MONTHLY WEATHER REVIEW,

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(General Weather Service of the United States.)

WAR DEPARTMENT,

Office of the Chief Signal Officer,

DIVISION OF

TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE AND AGRICULTURE.

INTRODUCTION.

In preparing this REVIEW the following data, received up to October 14th, have been used, viz: the regular tri-daily weather charts, containing the data of simultaneous observations taken at 144 Signal Service stations and 15 Canadian stations, as telegraphed to this office; 162 monthly journals and 160 monthly means from the former, and 15 monthly means from the latter; reports from 8 Sunset stations; 203 monthly registers from Voluntary Observers; 42 monthly registers from United States Army Post Surgeons; Marine Records; International Simultaneous Observations; monthly reports from Voluntary Observers in, and the local Weather Service of, Missouri; reliable newspaper extracts; special reports.

BAROMETRIC PRESSURE.

The general distribution of barometric pressure as exhibited on Chart No. II differs slightly from the mean pressure as determined from the observations for many years. The greatest variation from the mean occurs on the North Pacific coast, where the pressure is seven hundredths above the normal at Portland. The pressure has increased from three to six hundreths in all of the districts east of the Mississippi, and the area of mean high barometer which covered the Southern States in *September* has increased and moved north over the Middle Atlantic States and New England.

Barometric Ranges.—The barometric range for the several stations increases with the latitude and is unusually great in the Upper Mississippi valley and Upper Lake region, located near the track of the centre of the storm which passed over these regions on the 16th and 17th. The range increases on the Atlantic coast from 0.30 at Key West to 1.22 at Portland, Me., and in the Mississippi valley from 0.68 at New Orleans to 1.68 at La Crosse, this being the greatest range reported. In the Lake region the range varies from 0.89 at Rochester to 1,51 at Duluth. On the Pacific coast the range increases with the latitude but is much less than at corresponding latitudes on the Atlantic coast.

Areas of High Barometer.—Nine areas of high barometer have appeared within the limits of the Signal Service stations during the month of October, four of which—Nos. II, V, VII and IX were traced from the north Pacific to the Atlantic coast. No. VI apparently developed in the Southwest and followed the general direction of the storm of the 16th and 17th, being preceded by the most severe "norther" of the month on the Texas coast.

No. I.—This area was central near Philadelphia on the morning of the 1st and extended along the Atlantic coast from Maine to Florida, and from the Atlantic coast westward over all districts east of the Mississippi river. The general direction of the movement was to the east southeast, but the advance to the east was much retarded near the coast, the winds shifting to the east and south on the 2nd. Clear weather with slowly rising temperature prevailed in the eastern portion of the United States during the 2nd and 3rd as the area passed to the east over the Atlantic. The course of this area, previous to the 1st, has been given in the REVIEW for September, where it is described as No. VI.

No. II.—The reports from the Upper Missouri valley at midnight of the 1st indicated the advance of this area from British America and the North Pacific coast and the morning report of the 2nd showed that the entire region west of the Mississippi to the Pacific coast was within the limits of this area. The pressure increased to 30.20 on the Eastern Slope, and north to west winds and clear weather prevailed between the Mississippi river and the Rocky Mountains, except the light rains which preceded a "norther" on the Texas coast. On the morning of the 4th the centre was located near Dodge City, Kans., and a maximum velocity of wind of 33 miles from the north occurred at Indianola between the midnight and morning reports. High winds continued on the Texas coast during the 4th, the afternoon report showing a velocity of 36 miles from the north. As the centre passed to the Mississippi valley the winds shifted to northerly in the Gulf States on the 5th. The "norther" although severe in western Texas did not extend east of Indianola with sufficient force to justify Cautionary Signals at Galveston, the maximum velocity at the latter station being only 20 miles north on the morning of the 4th.

No. III.—The pressure continued above the normal over the western half of the continent during the 4th, when the preceding area was apparently re-inforced by area No. III, which was central in Montana where the pressure was thirty-five hundredths above the normal. The course of this centre during the 5th and 6th was almost directly east over the Lake region, where the area was central on the morning of the 7th. Fresh and brisk northwest winds were reported at the Lake stations and generally clear weather prevailed in the districts east of the Mississippi river, except in the southern portion of the South Atlantic States, which was within the limits of low area No. IV during the 7th. The pressure increased at the centre as this area passed to the east of the coast line over New England on the 8th and the gradient increased rapidly in the southwest quadrant as the tropical storm traced as No. IV moved to the northeast.

No. V—advanced from the North Pacific on the 9th, the p. m. report of that date showing a pressure above the normal at all stations in California, and twenty-four hundreths of an inch above at Olympia. The barometer rose rapidly during the 10th at stations between the North Pacific coast and the Lake region, the centre of greatest pressure being in the Upper Missouri valley, near Fort Buford, where it was forty-five hundreths of an inch above the normal on the morning of the 11th. During the 12th and 13th this area passed slowly to the eastward over the Lake region, attended by generally clear weather and frosts as far south as North Carolina. Brisk and high northwest to northeast winds prevailed on the Middle and South Atlantic coasts on the 14th, and on the 15th the centre passed to the east of the coast line when the wind, along the coast, shifted to the southeast and south as low area No. VI., then central near Dodge City, moved to the northeast. Heavy snows were reported at the Rocky Mountain stations on the 11th, when this area was central in the extreme Northwest, and an area of cold completely inclosed by the isothermal lines of 40° and 50° was plainly marked on the tri-daily weather maps. At the p. m. report of the 11th the temperature was 81° at Fort Gibson and 39° at Dodge City, and the crowding of the isothermal lines in the Southwest indicated the approach of the "norther" which occurred in the interior of Texas. Off-shore Signals were ordered at the stations on the Texas coast, but the wind, although shifting to the north, did not reach a high velocity on the immediate coast.

No. VI.—This area moved from the Southwest, the centre of greatest pressure following the general direction of the line marked as the track of low area No. VI. The violent "norther" which occurred at Indianola and Galveston was not anticipated owing to the failure of telegraph lines in the Southwest at the two preceding reports. The pressure increased in the southern portion of the United States during the 16th, 17th and 18th as this area developed and passed slowly to the east. It moved to the east off the Atlantic coast on the 19th, with a pressure of 30.30 extending from Jacksonville to Boston.

No. VII.—The a. m. telegraphic reports of the 20th indicated the advance of an area of high barometer from the North Pacific, the pressure at Olympia having increased to twenty-one hundredths above the normal, and at the a. m. report of the following day, the centre of this area had passed east of the Rocky mountains, the departure from the normal pressure being greatest in the Upper Missouri valley, where it ranged from +0.30 to +0.48. During the 21st, the pressure increased slowly over the regions west of the Mississippi and north of the Ohio river, accompanied by colder north to west winds. The centre of greatest pressure passed almost directly south and then to the east during the 22nd and 23rd, extending over the Southern States. Frosts were reported from Cedar Keys, Fla., Savannah and Atlanta, Ga., and Montgomery, Ala., on the morning of the 24th, when this area was central near Nashville, Tenn. The pressure continued high in the South Atlantic States until the 26th, when the winds shifted to the east and south, with rising temperature in advance of low-area No. IX. Severe local storms occurred in northern Texas, when the centre of this area was west of the Mississippi river, but the "norther," for which signals were ordered, did not reach the coast with the expected force.

No. VIII—followed low-area No. IX, moving to the southeast from the Saskatchewan region to the Upper Lakes, the centre remaining north of the stations of observation until it reached the St. Lawrence valley on the 28th, when it passed over New England and apparently moved to the south-

east, disappearing rapidly as low-area No. IX, moved to the northeast from the Gulf of Mexico. The reports from the extreme Northwest and the Pacific coast, show that this area did not pass from the North Pacific region, but indicate that it originated north of the United States and east of the Rocky mountains. Telegraphic observations from the Northwest Territory and west shore of Hudson's bay, would enable this office to anticipate the sudden changes in temperature which frequently occur in the northeastern and northern portions of the United States.

No. IX.—This area passed from the North Pacific over the Rocky Mountains on the 29th and moved southward on the 30th, accompanied by cold northerly winds and a light "norther" on the Texas coast, which continued during the 31st, the wind reaching a velocity of 31 miles per hour at Indianola, when the centre of greatest pressure was near Fort Gibson. North to west winds and clear, cold weather prevailed throughout all districts east of the Mississippi as this area moved slowly to the east over the Southern States on the 31st.

Areas of Low Barometer.—On chart No. I will be found the tracks of centres of the areas of low pressure, which have been traced from the tri-daily weather maps of the month. The mean latitude of these tracks is several degrees to the north of the mean latitude of low areas for corresponding month of previous years. Nos. IV, VIII and XI, were tropical storms, which developed south of latitude 25°, and No. VI, the most marked depression of the month, apparently developed in the southwest, probably in northern Texas. No. XII is the only depression that crossed the Rocky mountains, and this disappeared before reaching the Lake region.

No. I.—This depression had partially developed in the extreme Northwest during the latter part of September and on the 1st a trough of low pressure extended from Kansas north to British America, where the lowest pressures were reported. The course was southeast during the 1st and 2nd, passing over the Upper Lake region, attended by light rains as far south as the Ohio valley and heavy rains in the western quadrant, as the winds shifted to the west and north. At midnight of the 2nd, the direction of the movement changed to the no theast and the depression took the form of an extended trough, which rapidly disappeared. Rain continued in the Lower Lake region during the 3rd, and a second area of low barometer developed during the night, which remained central near Buffalo until the morning report of the 4th, when it passed northeastward into the St. Lawrence valley. Cautionary signals were ordered for stations on the Upper Lakes and Lake Erie, and were generally justified by the high winds which followed the display. High winds also occurred on Lake Ontario after the centre had passed to the east.

No. II.—This area apparently developed north of the Lake region and although high westerly winds occurred at several stations on Lakes Michigan, Huron and Erie, the weather remained clear or fair and the temperature remained above 50° at the northern stations. As this depression moved to the east, north of the stations of observation the track of its centre could only be located approximately. Severe westerly gales were reported in the lower St. Lawrence valley after the centre had reached the Atlantic coast.

No. III.—The barometer continued below the normal in the extreme Northwest from the 6th to the 9th, the centre of lowest pressure apparently advancing and receding and moving to the south as indicated by the loop-shaped track on Chart No. I. The easterly movement commenced as soon as high area No. V appeared on the Pacific coast, on the 9th, when this depression assumed a well defined elliptical form in the Upper Mississippi valley and passed rapidly to the northeast, causing but a slight disturbance in the western districts, notwithstanding the unusually low barometer at the centre at the afternoon report of the 9th when the gradient was decided in the eastern half of the depression. Signals were ordered for stations on the Upper Lakes for the storm on the 7th, but lowered and ordered a second time on the 9th, when they were generally justified, but owing to the course of the centre, the storm was less severe than was anticipated.

No. IV.—Marine reports from the Gulf of Mexico indicate that this passed from the northern portion of Yucatan across the Gulf as a severe storm, and its course is well marked after the centre came within the limits of the signal stations. The wind increased in force along the Florida coast during the night of the 8th, and very heavy rains were reported in the southern portion of the South Atlantic States as far north as Cape Hatteras. At the afternoon report of the 8th, the centre was between Cedar Keys and Jacksonville and the gale had increased on the coast. Signals had been displayed at stations south of Norfolk, and special warnings sent to the principal cities on the Atlantic coast, informing captains and shipmasters about to proceed south of the storm on the coast. The wind reached a velocity of 52 miles at Savannah; 40 at Smithville; 37 at Charleston; 32 at Kittyhawk and 39 at Cape Henry.

No. V.—This area was central in the Upper Missouri valley on the morning of the 13th, and probably developed east of the Rocky Mountains in British America. It was first observed as a depression, central within the limits of the Signal Service stations, at midnight of the 13th near Yankton, after which it moved to the northeast over the northern portion of the Lake region. The barometer was decidedly low at the centre on the morning of the 14th, that at St. Paul reading 29.24. High winds prevailed over Lakes Michigan and Superior as the depression passed from St. Paul to the north of the Upper Lake region, the velocity at Milwaukee reaching 33 miles, SW., and at Esca-

naba, 32, S. Dangerous winds extended over Lake Huron, but the rapid movement of the storm toward Hudson's Bay decreased the gradients in the Lower Lake region. The signals ordered for this storm were continued for the succeeding storm, which had partially developed south of the Missouri valley on the 15th, with indications that it would prove dangerous to shipping in the Lake region.

No. VI.—This depression was central near Dodge City, Kan., on the morning of the 15th with areas of high barometer to the southeast and northwest. The pressure at Portland, Or., and Olympia being respectively 30.56 and 30.58. During the day the pressure decreased rapidly to the north and east of the centre, and at the afternoon report the area was well defined as central near Leavenworth, the temperature being high in the eastern quadrants and very low, with snow, from the Missouri river westward to Colorado and Wyoming. The storm increased in violence as the depression moved to the northeast, many of the observers in Iowa and the adjoining states reporting it as the most violent storm that has occurred in twenty years. The midnight report of the 15th indicated that the storm had continued its northeasterly course to the northeastern portion of Iowa, the barometer at St. Paul being 29.23, and that at Davenport 29.24. The isobarometric lines of 29.30, 29.40, 29.50 and 29.60 completely inclosed the depression in the Upper Mississippi valley and the Upper Lake region. At this report heavy snow, blockading railway trains, were reported in the region between the Mississippi and the Missouri river, and more than one inch of rain fell at St. Louis, Madison, Indianapolis, Toledo and Cairo. The course changed to the north during the night and the pressure at the centre continued to decrease until it reached 28.85 at St. Paul and 28.86 at La Crosse, the barometric gradient at this time being about four-tenths of an inch for one hundred miles. During the 16th this storm continued, with great violence, in the Lake region, but observers report that many vessels were saved by the warnings given by the cautionary signals which were displayed at the lake ports in advance of this storm. When the wind shifted to the southwest it increased in force, reaching 60 miles per hour at Milwaukee, 48 miles at Grand Haven and 45 miles at Escanaba in the afternoon of the 16th. The observer at Chicago reports: "The wind continued with but slight abatement until 2:15 a. m. of the 17th. One unknown schooner reported sunk out in the lake a short distance from port; owing to the timely warning this is the only serious disaster yet reported to shipping in South Chicago. 'North Chicago Rolling Mills', partially built, walls fourteen inches thick, blown down, burying several men in the ruins. The steamer *Alpena* which left Grand Haven on the night of the 15th with 60 passengers, is also believed to be lost. This vessel was seen from other vessels 30 miles from Chicago. Almost all vessels arriving at port bear evidence of rough usage. The height of the waves and the fury of the storm is the subject of general comment among all mariners." The observer at Escanaba reports: "Three-masted schooner *Evening Star* went ashore on the west side of the bay and was landed clear out of the water, wind from east in early morning, veered to southwest at 8 a. m., on the 16th increasing in force, reaching the maximum, 45 miles per hour at 2:30 p. m., when the wind vane was blown from the roof." The storm continued in the Upper Lake region during the 17th and extended over the Lower Lake region. The observer at Buffalo reports:—"A maximum velocity of 48 miles from the west at 6 p. m., and the gale continued until 2:30 p. m. of the 18th. A large number of vessels remained in this port by advice given upon the receipt of the special telegram from the central office announcing a severe storm. Favorable comments were made upon the display of this signal and the absence of disasters in this vicinity was attributed to the timely display of the signal." The storm seems to have been most violent on Lake Michigan where the wind forced the water to the lower end of the lake, causing it to rise eight or ten feet above the usual level, thus driving vessels ashore and destroying property near the lake. Reliable estimates have been made which place the value of property lost at a little more than half a million of dollars; 84 vessels were wrecked and 93 lives lost, more than four-fifths of all losses occurring on Lake Michigan. As the centre passed to the northeast of Lake Superior the temperature fell decidedly in the western quadrants, accompanied by snow throughout the Lake region and southward to Kentucky, and killing frosts occurred as far south as the northern portion of the Gulf States.

No. VII.—This depression was at no time central within the limits of the stations of observation, and probably developed in the Saskatchewan region and passed eastward to the lower St. Lawrence valley during the 20th and 21st, moving first to the southeast and then north of east as it approached the coast. Signals were ordered for the Lake stations and were generally justified, although no violent winds were reported.

No. VIII.—Threatening weather and heavy rains on the South Atlantic coast on the 21st, indicated the approach of this depression, and at the midnight report it was probably central near latitude 30° north, and longitude 4° east of Washington. Easterly winds of 43 miles at Cape Hatteras and 40 miles at Cape Lookout, were reported with heavy rains on the coast between Cedar Keys and Norfolk. The pressure decreased on the Middle and East Atlantic coasts during the night of the 22nd, with rain extending to the north as far as Philadelphia. The wind had increased to 41 miles from the NE. at Cape Henry, and at Cape Lookout it had shifted to the N. with a velocity of 42 miles. The barometer fell rapidly on the Middle Atlantic coast during the 22nd, the pressure at the Deleware Breakwater being 29.69 at 3 p. m., with the wind from the NE., 48 miles. The shifting of the wind to the NW. at Hatteras indicated that the centre had passed to the north of that latitude, and that

it was not far to the east of the coast. During the night of the 22nd the wind shifted to the NW. at stations south of New England, and the barometric gradient increased rapidly in front of the storm as the centre approached the New England coast. Rain and snow prevailed in the Lower Lake region, Middle States and New England, on the 22nd and 23rd, and dangerous winds occurred at all coast stations north of Wilmington, N. C. The barometer continued to fall at the centre until the storm reached the coast line, near Portland, on the morning of the 23rd, when the reading was 29.26. Severe easterly gales were reported from the St. Lawrence valley, New Brunswick and Nova Scotia. The maximum velocity report at Eastport was 53 miles from the E., 42 miles at Father Point, high winds at Quebec and 33 miles from the N. at Saugeen. After reaching the coast of Maine the course changed to the N., and by midnight of the 23rd the centre had passed to the lower St. Lawrence valley near Father Point. Cautionary Signals were ordered at all stations on the Lower Lakes and on the Atlantic coast, and were justified at all stations north of Wilmington.

No. IX.—This depression developed in the Upper Missouri valley, while the preceeding one (No. VIII,) was central in the Gulf of St. Lawrence. It moved almost directly east over the parallel of 45° until it passed to the east of the Atlantic coast on the 27th. During the 25th the centre moved from Dakota to the Upper Lake region, its approach having been announced by the display of Signals at the lake ports. The centre passed over Lake Michigan immediately north of Milwaukee, the area of rain extending south to Tennessee and east to the Atlantic coast. The Cautionary Signals displayed were generally justified, except in New England.

No. X.—This storm developed in the tropics and was central in the Gulf of Mexico, east of Brownsville at the p. m. report of the 27th. Heavy rains and cold northerly winds prevailed on the Texas coast. Indianola reported a maximum velocity of 56 miles on the 27th. The "norther" continued on the Texas coast as the centre moved toward the Mississippi and the area of rain extended north to the Ohio valley and the southern portion of the South Atlantic States on the 28th. The average hourly velocity of this storm was 19 miles, in a northeast direction over a course nearly parallel to the coast. Rain fell in all districts east of the Mississippi, the rain-fall being greatest in the Southern States and near the centre of the storm as it moved over the Middle States and New-England. The barometer fell rapidly as the depression moved to the northeast and at the p. m. report of the 31st, a large area including the greater portion of New England, was completely inclosed by an isobarometric line of 29.30. Over an inch of rain fell during the last eight hours of the 31st at Portland, Eastport and Father Point. A maximum velocity of 40 miles from the SE. was reported at Eastport, when the centre was to the northwest of this station in Maine. The Cautionary Signals displayed in advance of this storm gave timely warnings and were of great service, especially at the ports on the northeast coast.

No. XI.—This depression was first observed in the Northwest, near the northern boundary of United States, at the p. m. report of the 27th, and continued in that region until the midnight report of the 28th, when it apparently joined an area which had passed from the Pacific coast. This depression although extended, was slight and after moving slowly to the east until the p. m. report of the 29th, disappeared.

No. XII.—This was a slightly marked area central in the interior of California on the 28th, and the movement to the east can be readily traced on the Study-Map of "Departures from the Normal." It appears to have united with the preceeding one, near Deadwood, at the midnight report of the 28th.

INTERNATIONAL METEOROLOGY.

Three International charts, Nos. IV, V and VI, accompany the present Review. They are for the months of *September*, 1880 and *February*, 1879.

Chart No. IV.—On this *preliminary* chart are shown, as well as is at present possible, the tracks of some of the principal storms centres over the North Atlantic Ocean and adjacent land areas during the month of *September*, 1880. Nos. I and II are the extended tracks of the tropical storms already described in previous *Reviews*. It seems probable that these storms united in forming a large area of low barometer over the northwestern portion of the Atlantic during the 6th, and which moved slowly eastward, unaccompanied by severe winds, until it disappeared on the 11th to the northwest of Scotland. The high barometer prevailing to the northward of the centres of the two cyclones above referred to may be here noted as an interesting feature in connection with the two storms, and by which the severity of the winds in the northern quadrants were increased. Thus on August 27th and 28th, while the former cyclone was approaching the coast of Florida, high pressures (from 30.20 to 30.30) were prevailing throughout the Atlantic States and Canada, and during the first few days of September, while the latter cyclone was moving eastward from the Bermudas high pressures, increasing on September 2nd to 30.35, prevailed between it and Newfoundland. The disturbance formed by the probable junction of these cyclones was preceded over the northeastern portion of the Atlantic by a somewhat severe storm, whose path is shown on the chart as No. IV. It appeared on the morning of the 3rd. Bark *Carrie Heckle* reports 3rd, 7:35 a. m., W. T., 50° N. 26° W., barometer 29.70, S. by W., fresh, threatening; 4 p. m., G. T., wind came from the north and blew a gale all night, accompanied by very heavy rain-squalls; early on the morning of the 4th, barometer rising, the wind backed to WNW., with clearing weather. On the 4th, S. S. *Indiana*, in